# Fig.1

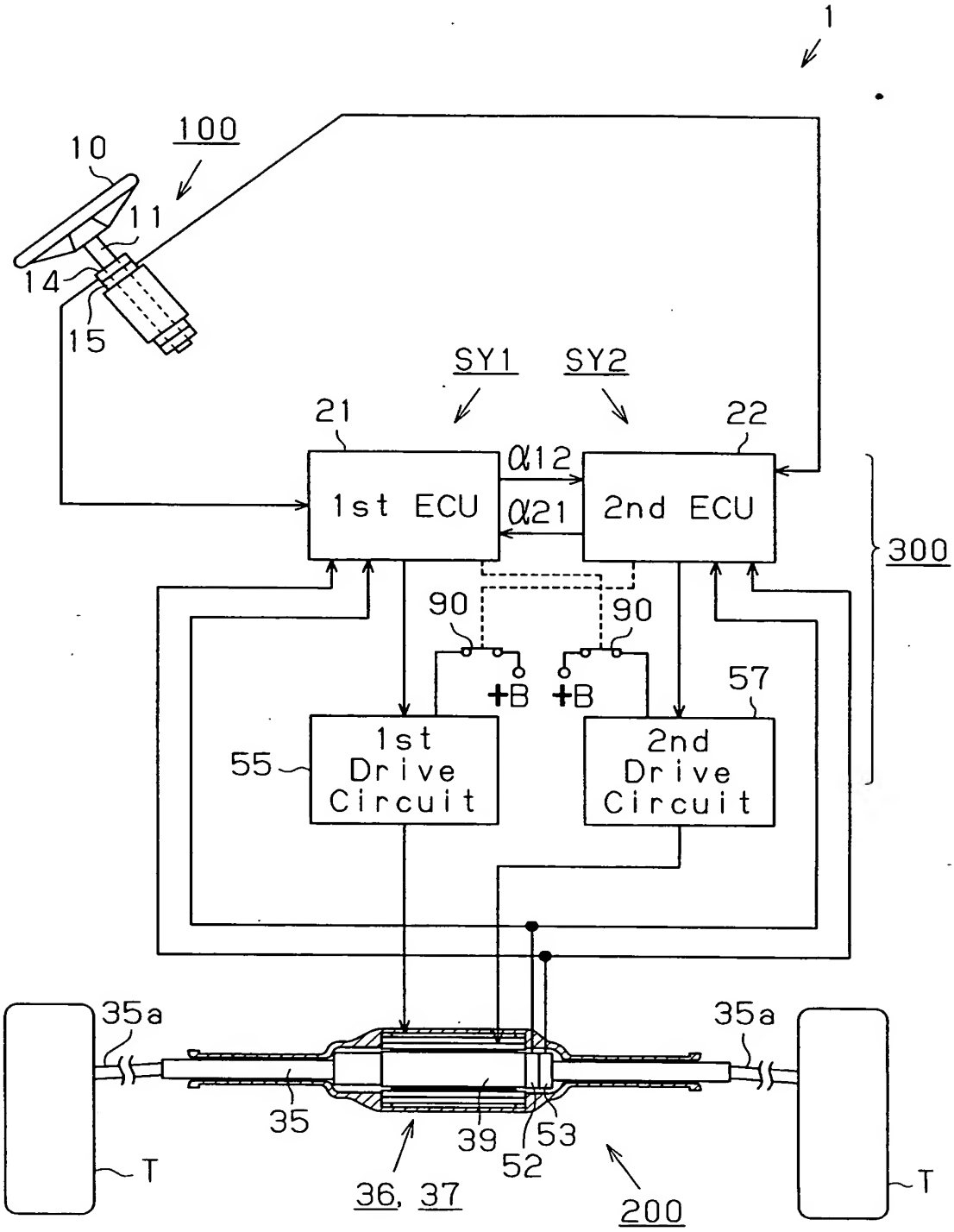
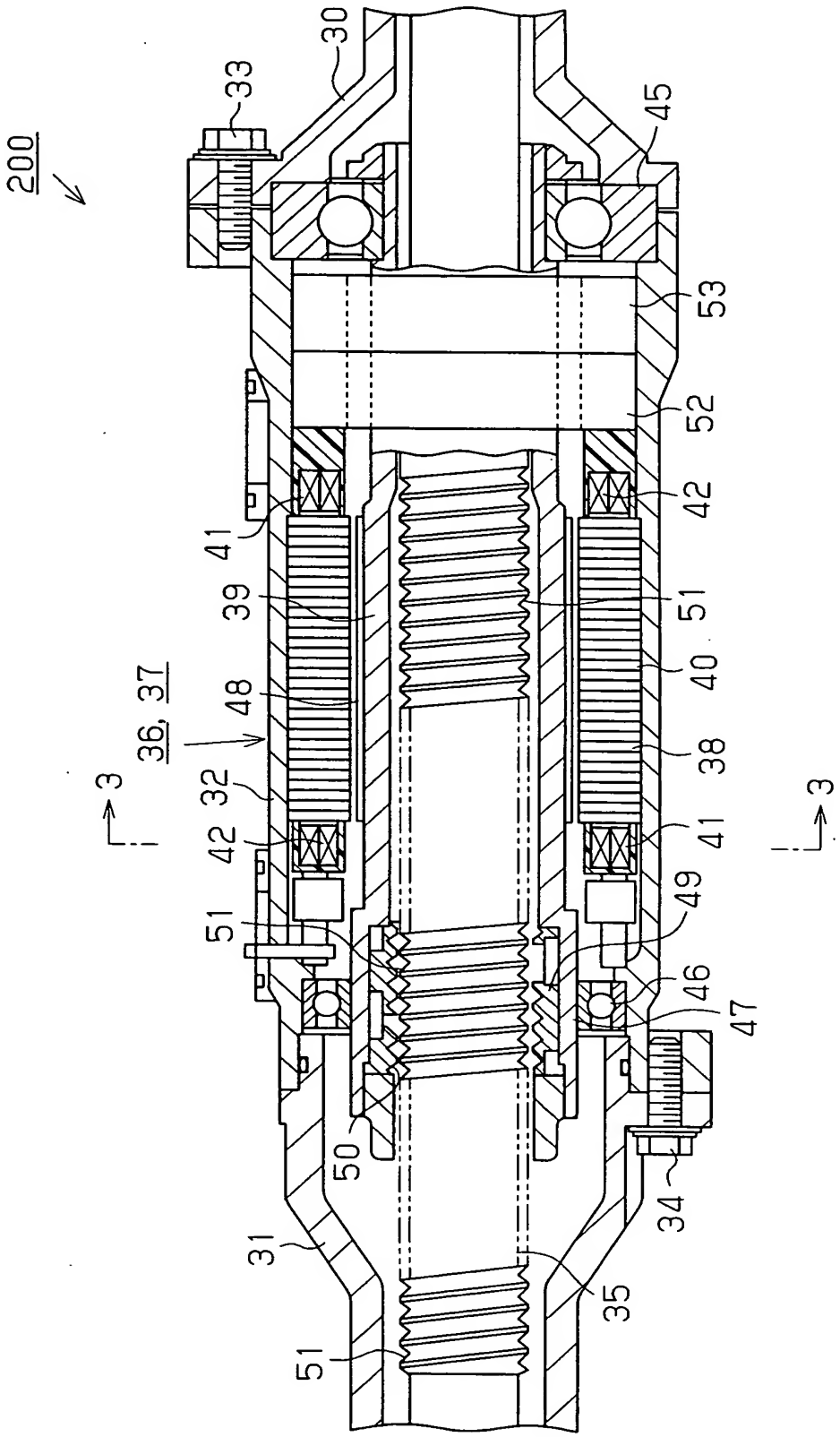
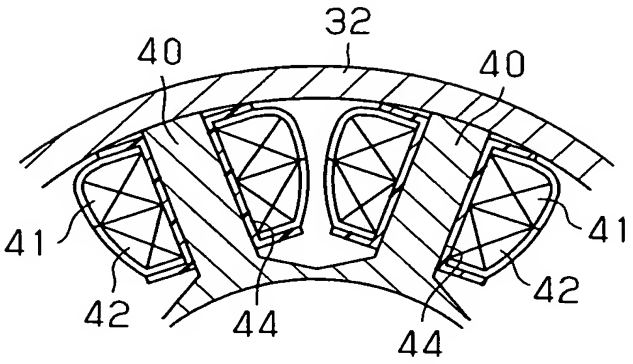

1
100
10
11
14
15
SY1
SY2
21
22
α12
α21
1st ECU
2nd ECU
300
90
90
+B
+B
57
55
1st Drive Circuit
2nd Drive Circuit
35a
35a
35
39
53
52
36, 37
200
T
T

Fig.2


200
30
33
45
53
52
42
41
39
51
40
36, 37
48
38
3
32
42
41
3
49
51
46
47
50
34
31
35
51

# Fig.3


32
40
40
41
41
42
42
44
44

# Fig.4

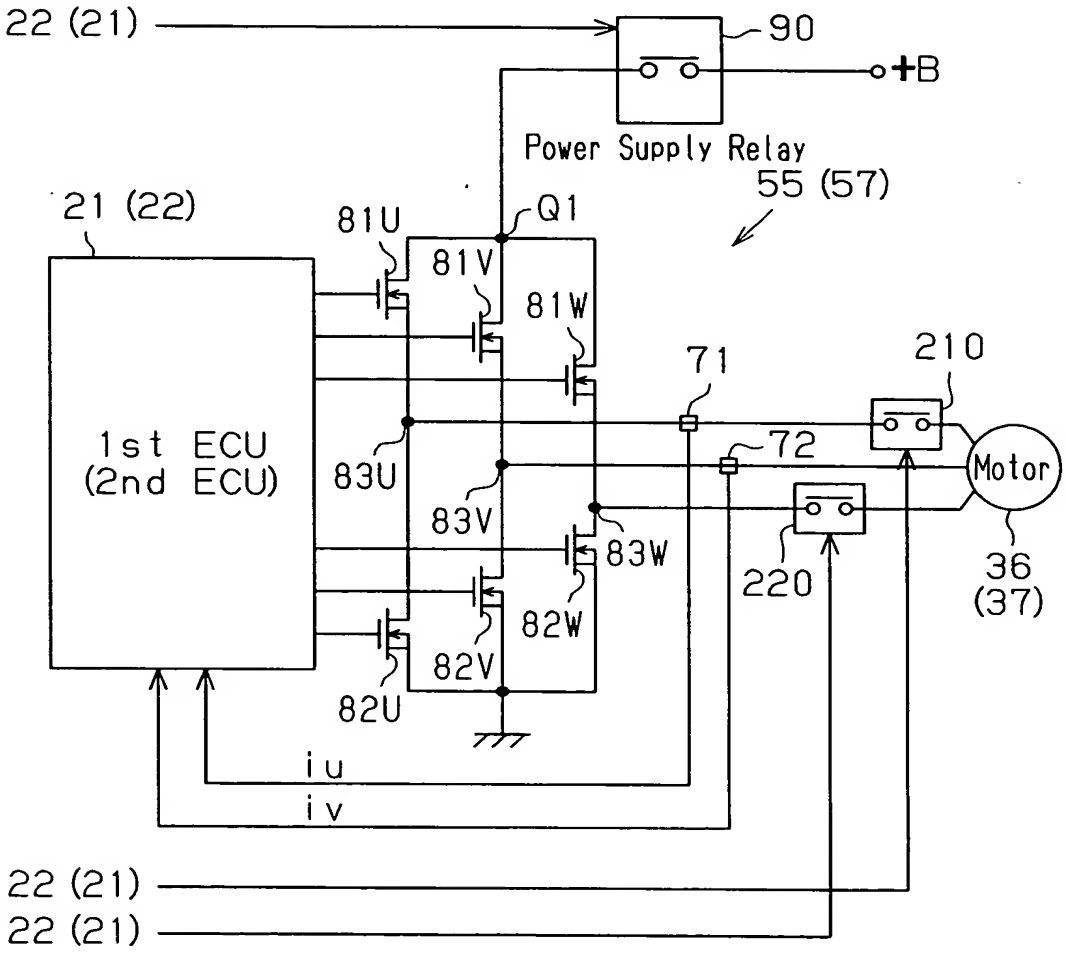

22 (21)
90
+B
Power Supply Relay
55 (57)
21 (22)
81U
Q1
81V
81W
71
210
1st ECU
(2nd ECU)
83U
72
Motor
83V
83W
220
36
(37)
82W
82V
82U
iu
iv
22 (21)
22 (21)

Fig.5

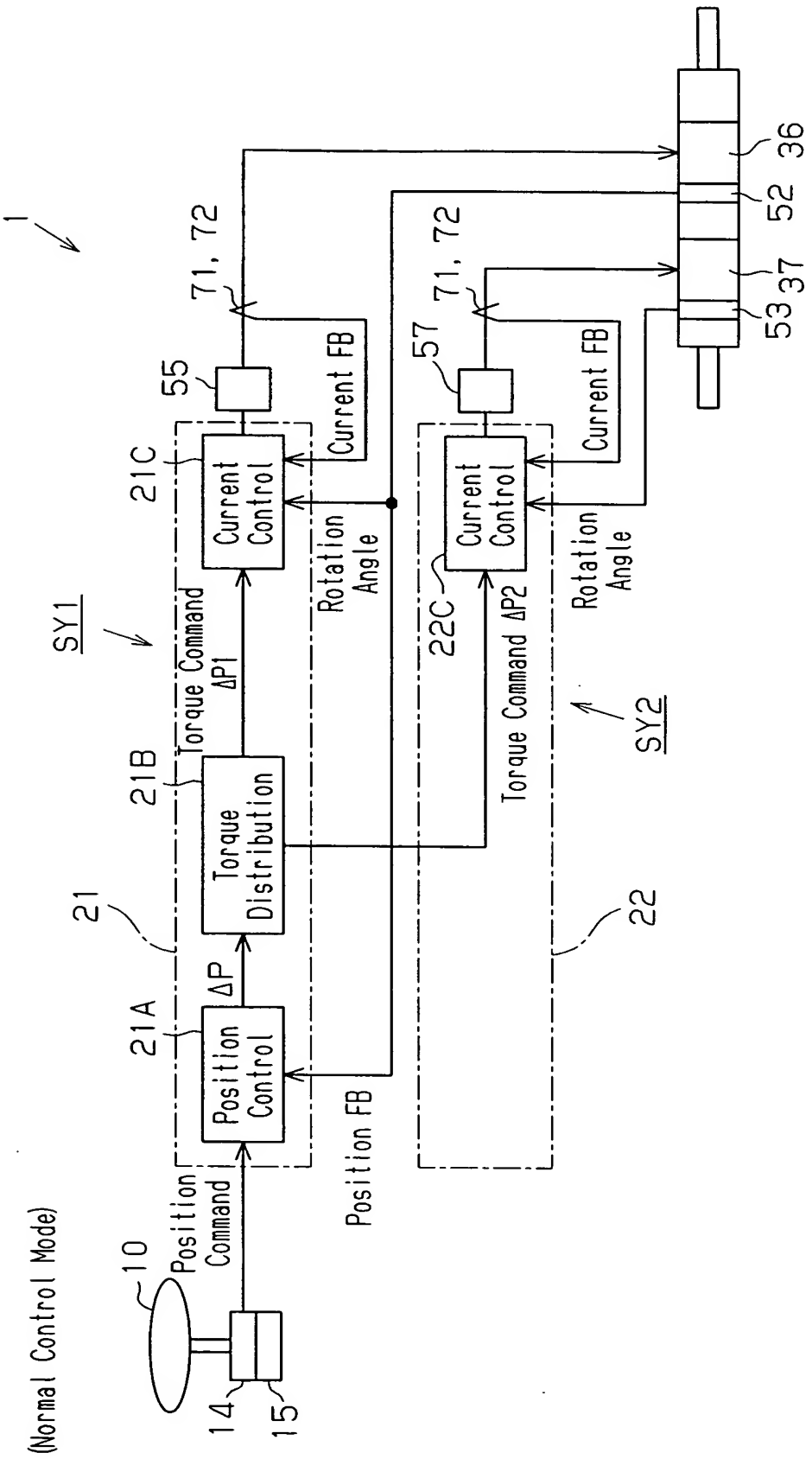

(Normal Control Mode)
1
10
Position Command
14
15
21
21A
Position Control
ΔP
21B
Torque Distribution
Torque Command ΔP1
21C
Current Control
55
71, 72
Current FB
Rotation Angle
Position FB
SY1
22
22C
Current Control
57
71, 72
Current FB
Rotation Angle
Torque Command ΔP2
SY2
36
52
37
53

Fig.6

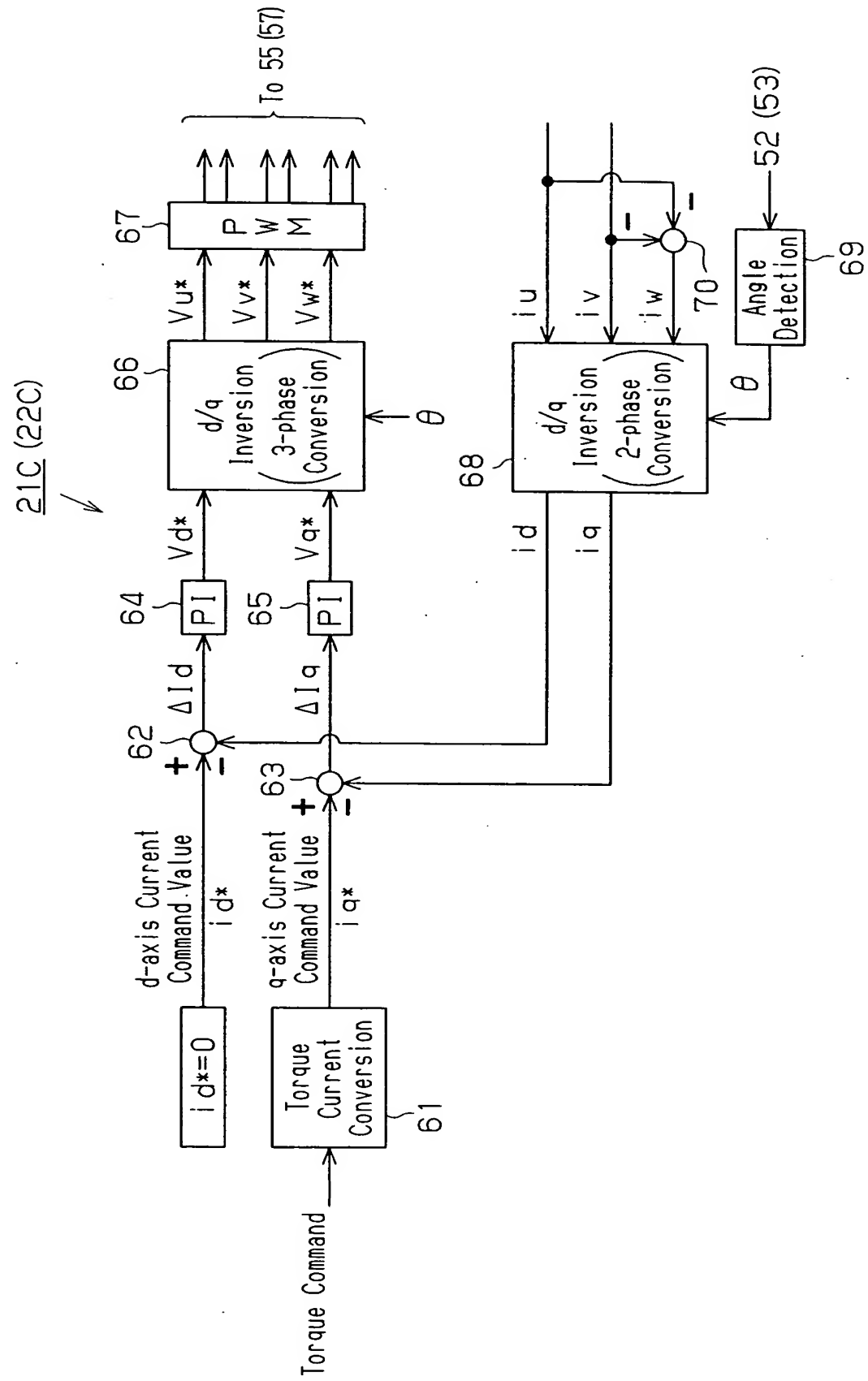
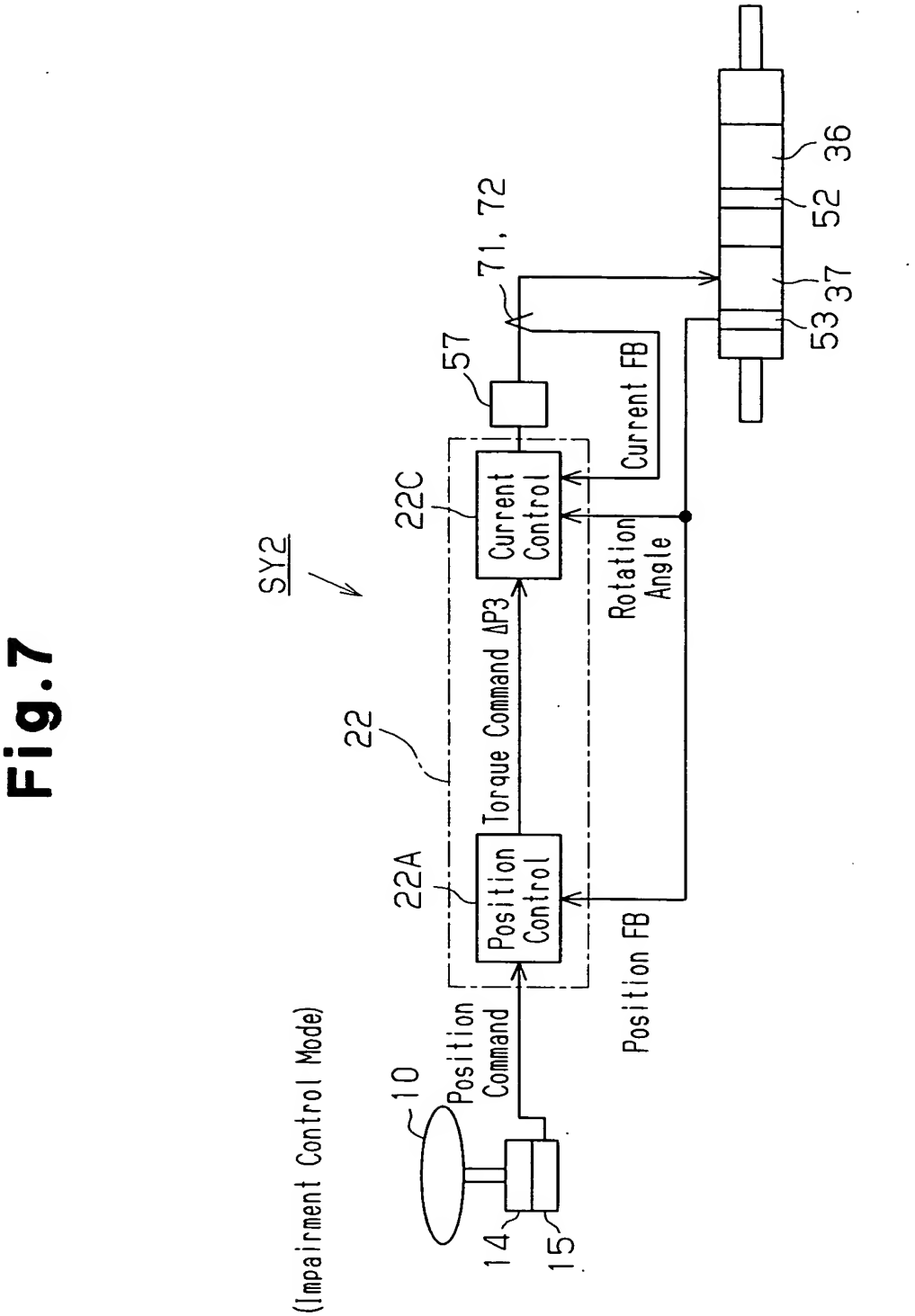

21C (22C)
To 55 (57)
67
PWM
Vu*
Vv*
Vw*
66
d/q Inversion (3-phase Conversion)
θ
Vd*
Vq*
64
PI
65
PI
ΔId
ΔIq
62
63
d-axis Current Command Value
id*
q-axis Current Command Value
iq*
id*=0
Torque Current Conversion
61
Torque Command
iu
iv
iw
70
68
d/q Inversion (2-phase Conversion)
id
iq
θ
52 (53)
Angle Detection
69

Fig.7


SY2
(Impairment Control Mode)
10
Position Command
14
15
22
22A
Position Control
Torque Command ΔP3
22C
Current Control
57
71, 72
Current FB
Rotation Angle
Position FB
36
52
37
53

# Fig 8

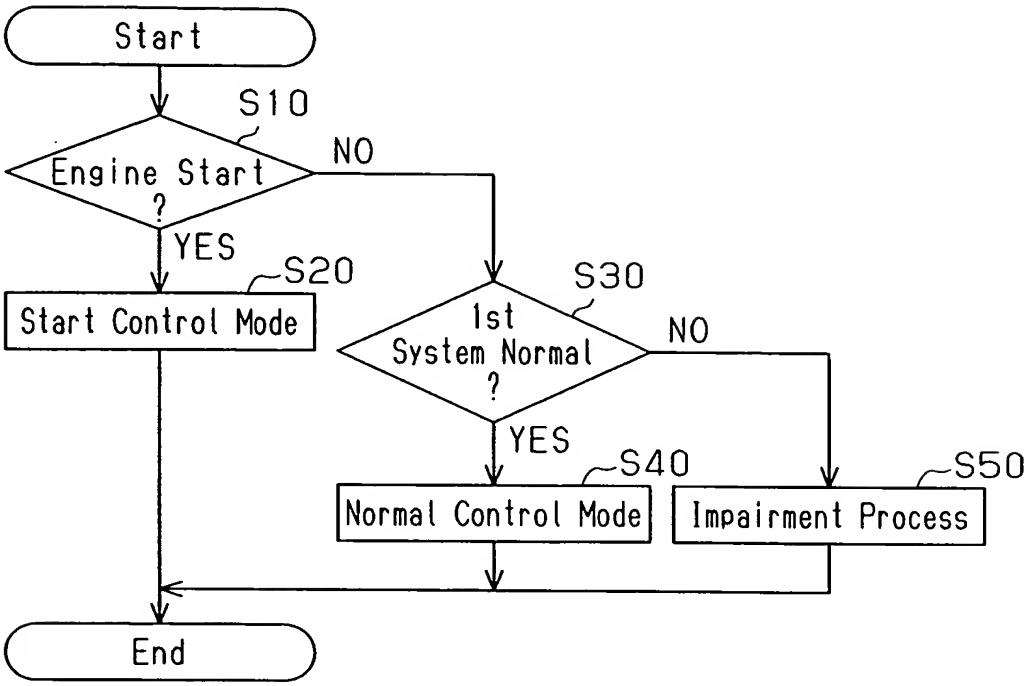

Start
S10
Engine Start ?
NO
YES
S20
Start Control Mode
S30
1st System Normal ?
NO
YES
S40
Normal Control Mode
S50
Impairment Process
End

Fig.9(Prior Art)

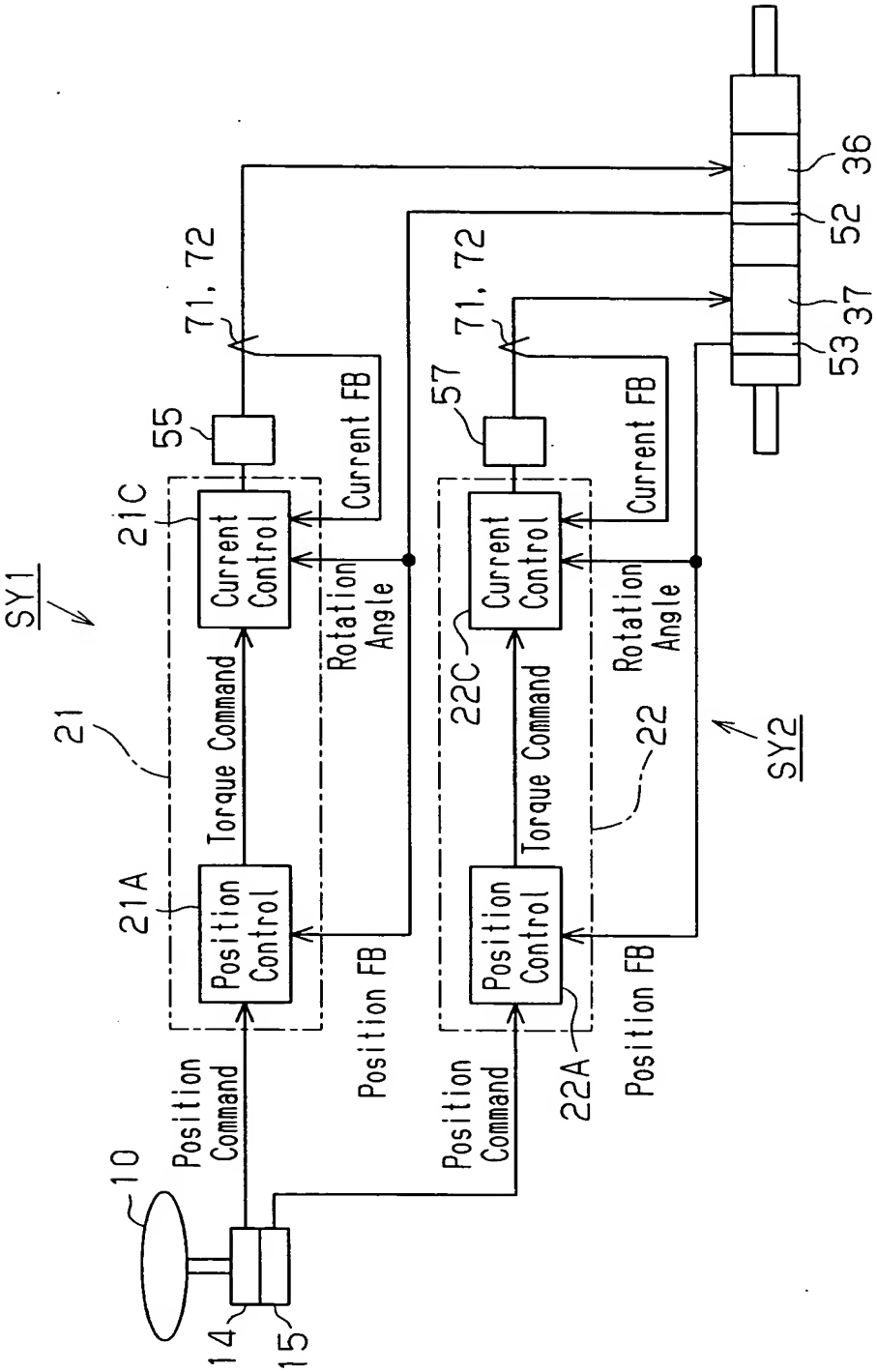


Fig.10

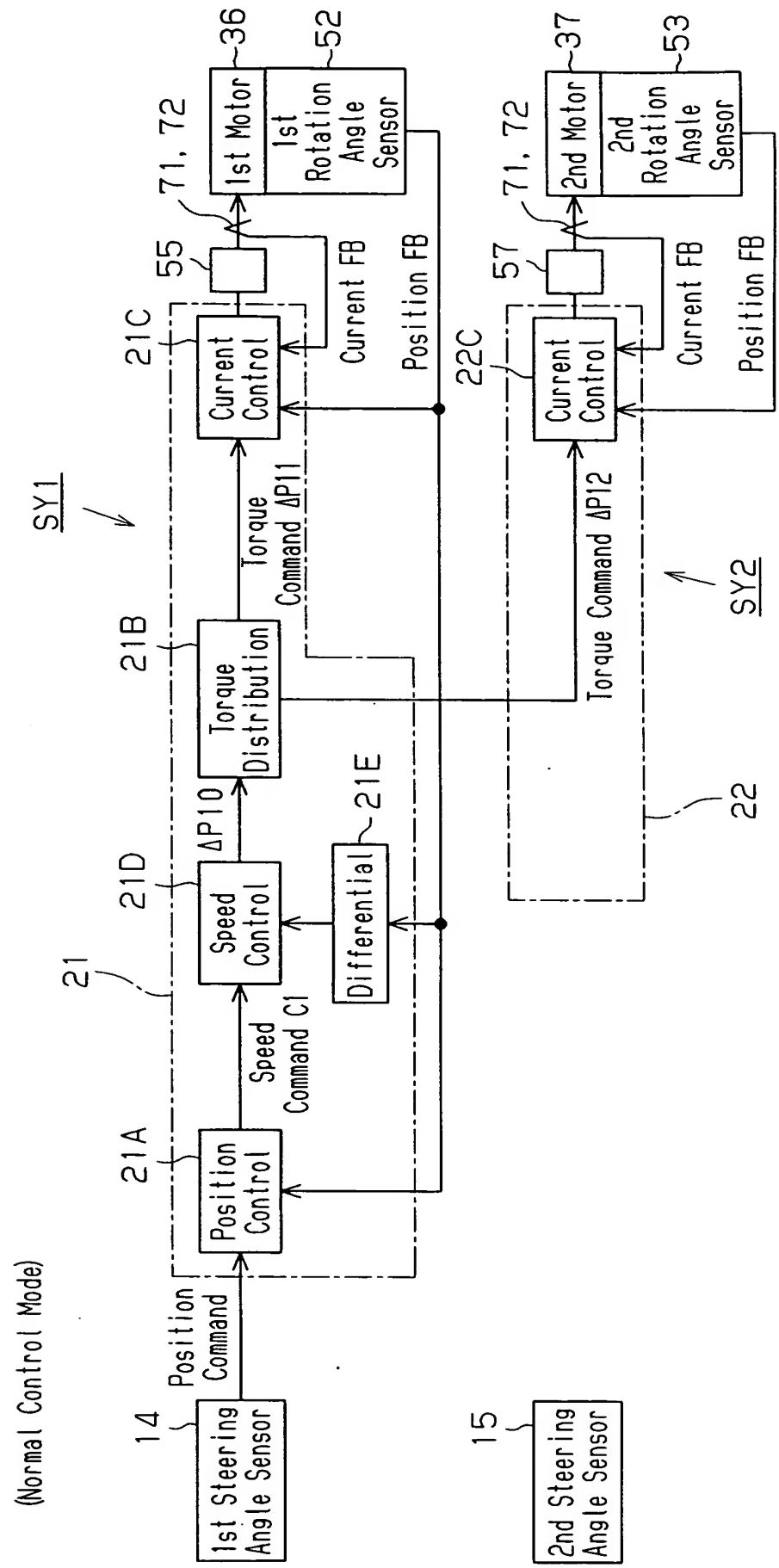
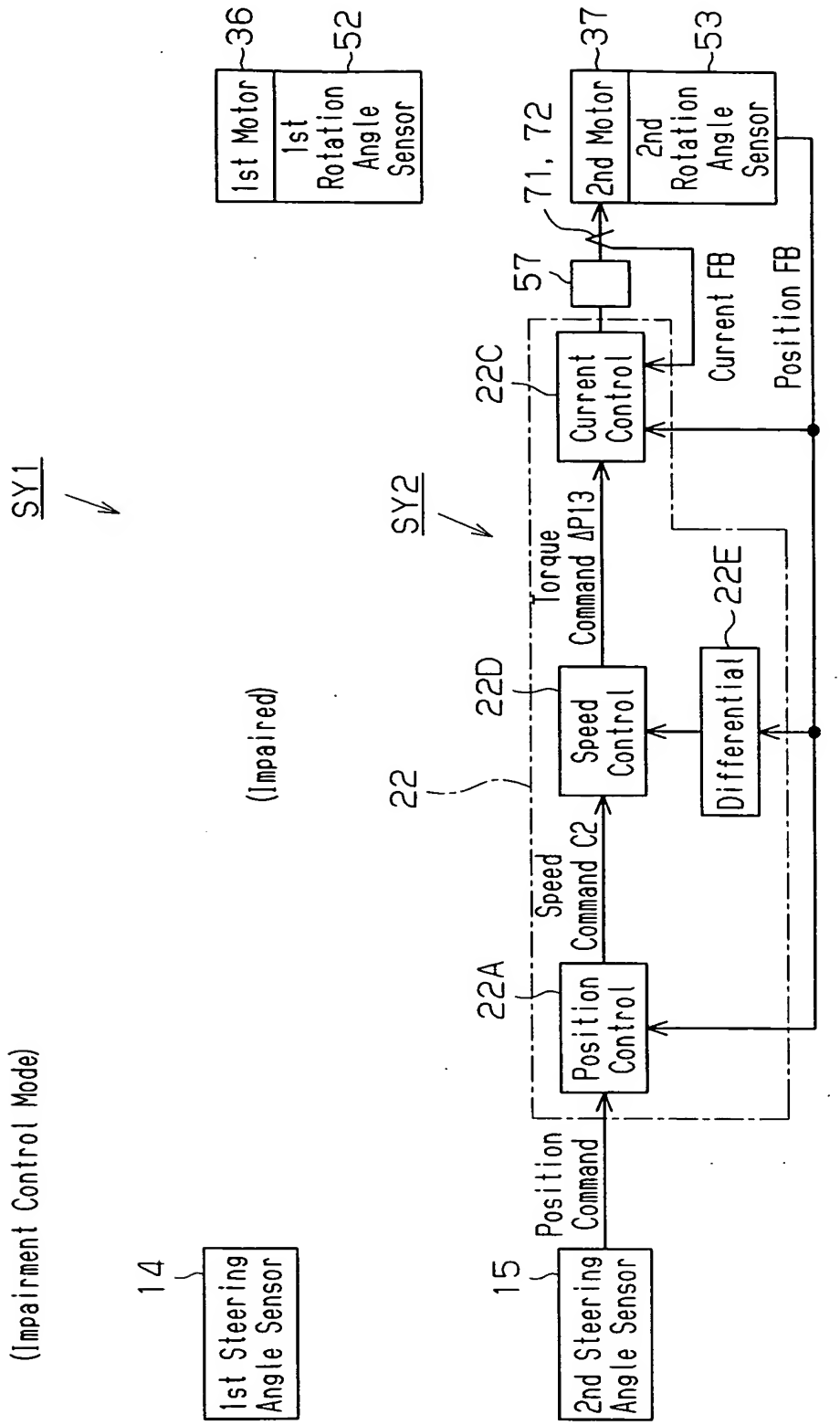

(Normal Control Mode)
1st Steering Angle Sensor
14
Position Command
Position Control
21A
Speed Command C1
Speed Control
21D
ΔP10
Torque Distribution
21B
Torque Command ΔP11
Current Control
21C
55
71, 72
1st Motor
36
1st Rotation Angle Sensor
52
Current FB
Position FB
21
Differential
21E
SY1
2nd Steering Angle Sensor
15
Torque Command ΔP12
Current Control
22C
57
71, 72
2nd Motor
37
2nd Rotation Angle Sensor
53
Current FB
Position FB
22
SY2

Fig.11


(Impairment Control Mode)
SY1
(Impaired)
SY2
14
1st Steering Angle Sensor
15
2nd Steering Angle Sensor
Position Command
22A
Position Control
Speed Command C2
22
22D
Speed Control
Torque Command ΔP13
22C
Current Control
57
71, 72
1st Motor
36
1st Rotation Angle Sensor
52
2nd Motor
37
2nd Rotation Angle Sensor
53
Differential
22E
Current FB
Position FB

# Fig.12

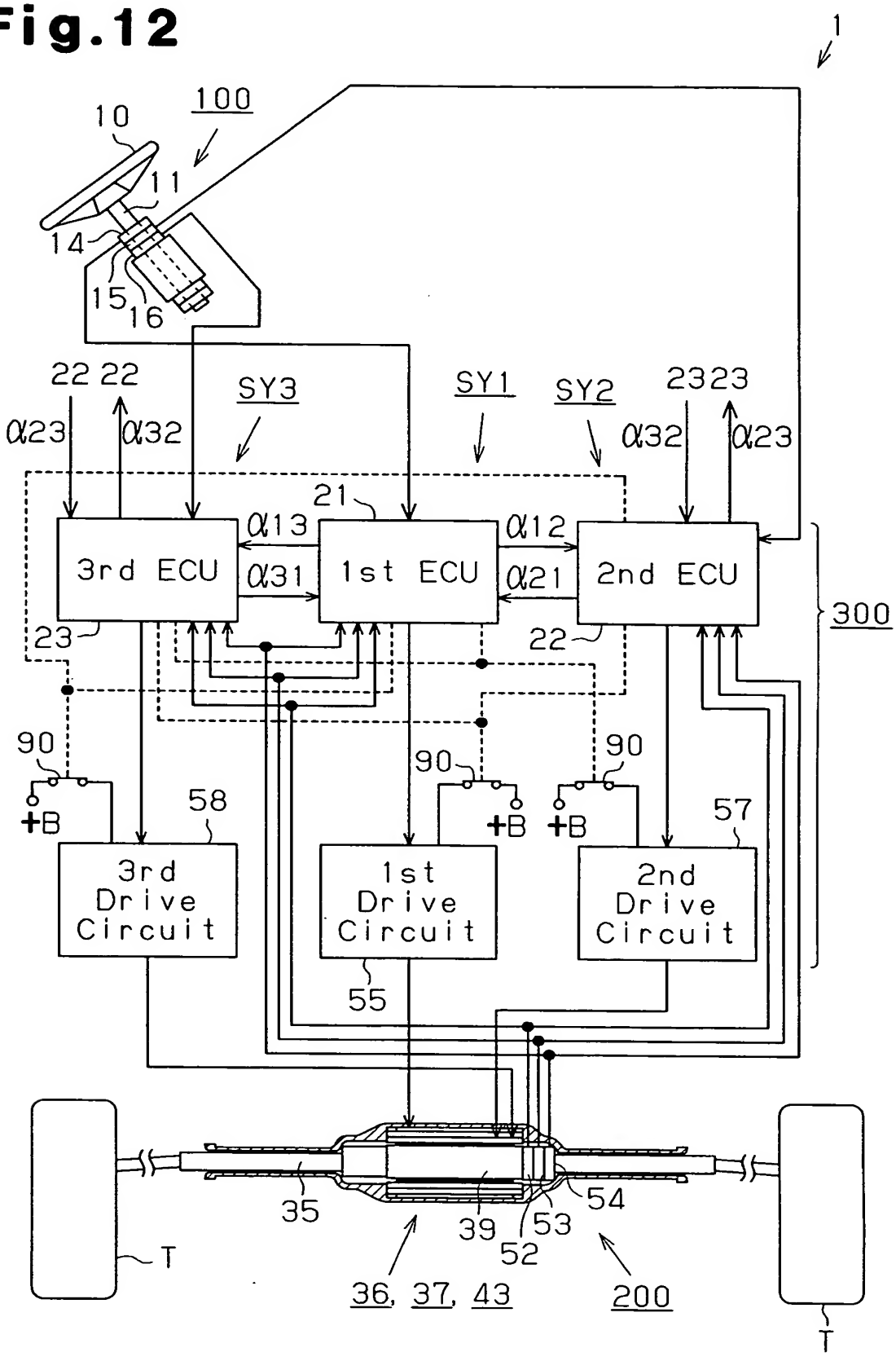

1
100
10
11
14
15
16
22 22
α23
α32
SY3
SY1
SY2
2323
α32
α23
21
α13
α12
3rd ECU
α31
1st ECU
α21
2nd ECU
300
23
22
90
90
90
+B
+B
+B
58
57
3rd Drive Circuit
1st Drive Circuit
2nd Drive Circuit
55
35
39
53
54
52
T
36, 37, 43
200
T

Fig.13

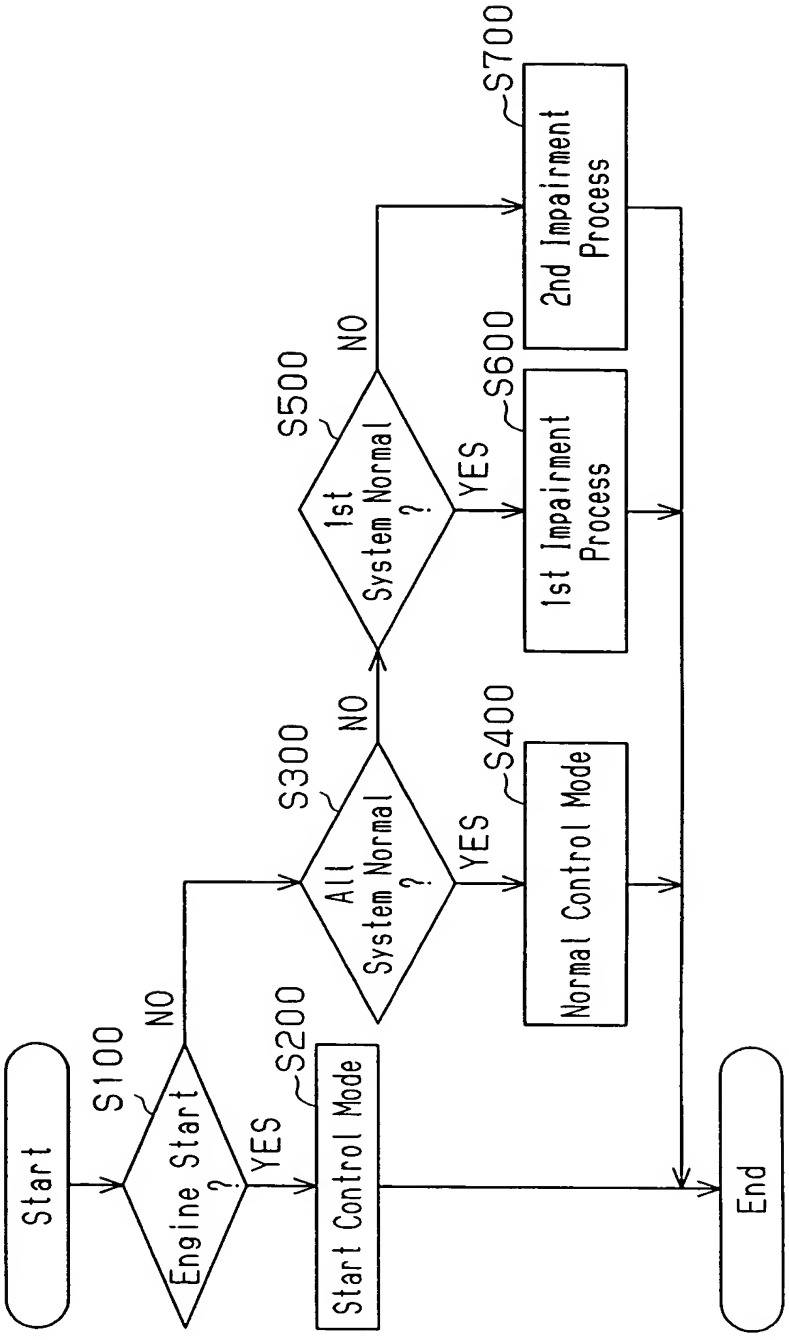

Start
S100
Engine Start ?
NO
YES
S200
Start Control Mode
S300
All System Normal ?
NO
YES
S400
Normal Control Mode
S500
1st System Normal ?
NO
YES
S600
1st Impairment Process
S700
2nd Impairment Process
End

Fig.14

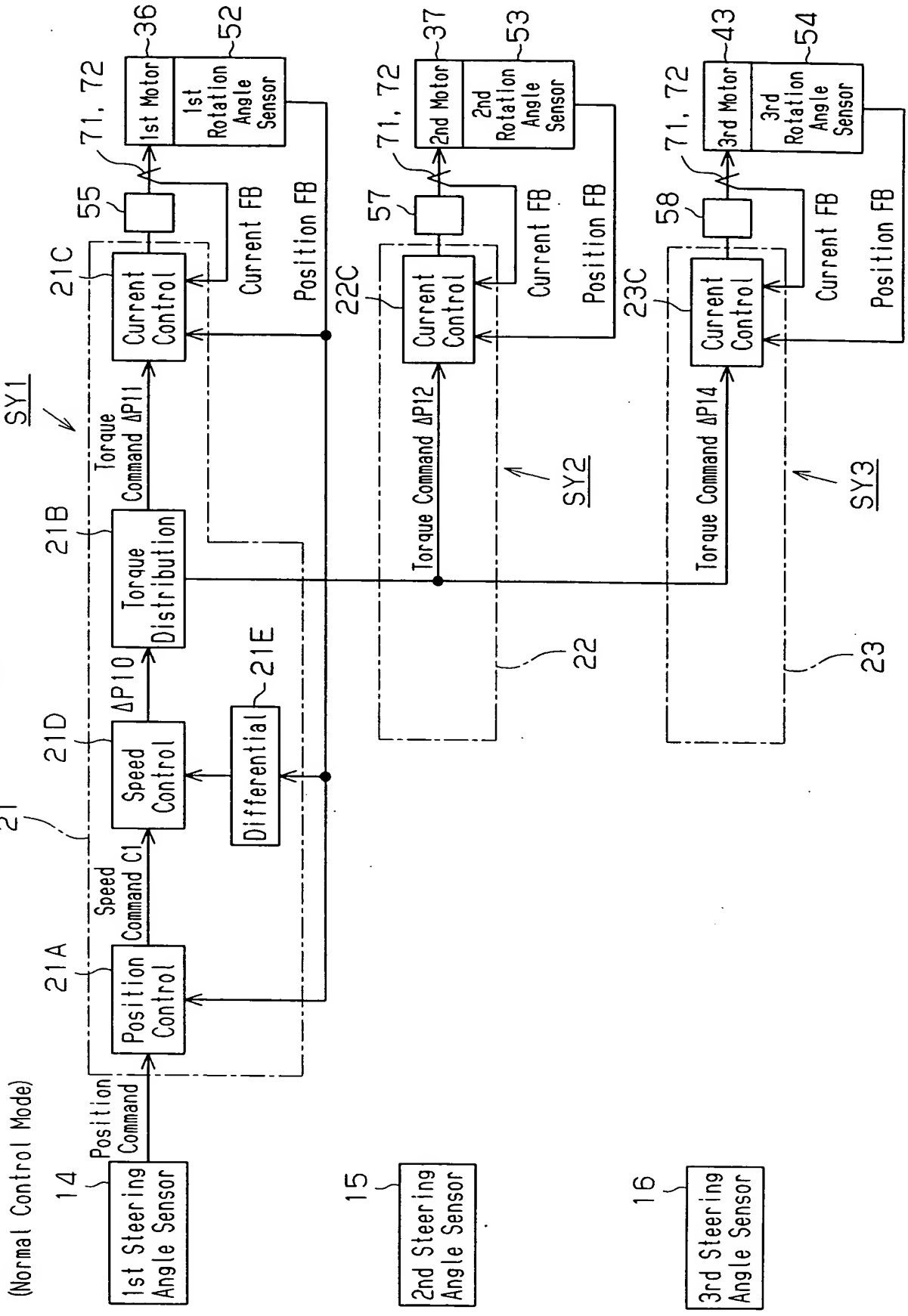

(Normal Control Mode)
1st Steering Angle Sensor
14
Position Command
21A
Position Control
Speed Command C1
21
21D
Speed Control
ΔP10
21B
Torque Distribution
Torque Command ΔP11
21C
Current Control
55
71, 72
1st Motor
36
1st Rotation Angle Sensor
52
Current FB
Position FB
SY1
Differential
21E
2nd Steering Angle Sensor
15
Torque Command ΔP12
22C
Current Control
57
71, 72
2nd Motor
37
2nd Rotation Angle Sensor
53
Current FB
Position FB
SY2
22
3rd Steering Angle Sensor
16
Torque Command ΔP14
23C
Current Control
58
71, 72
3rd Motor
43
3rd Rotation Angle Sensor
54
Current FB
Position FB
SY3
23

Fig.15

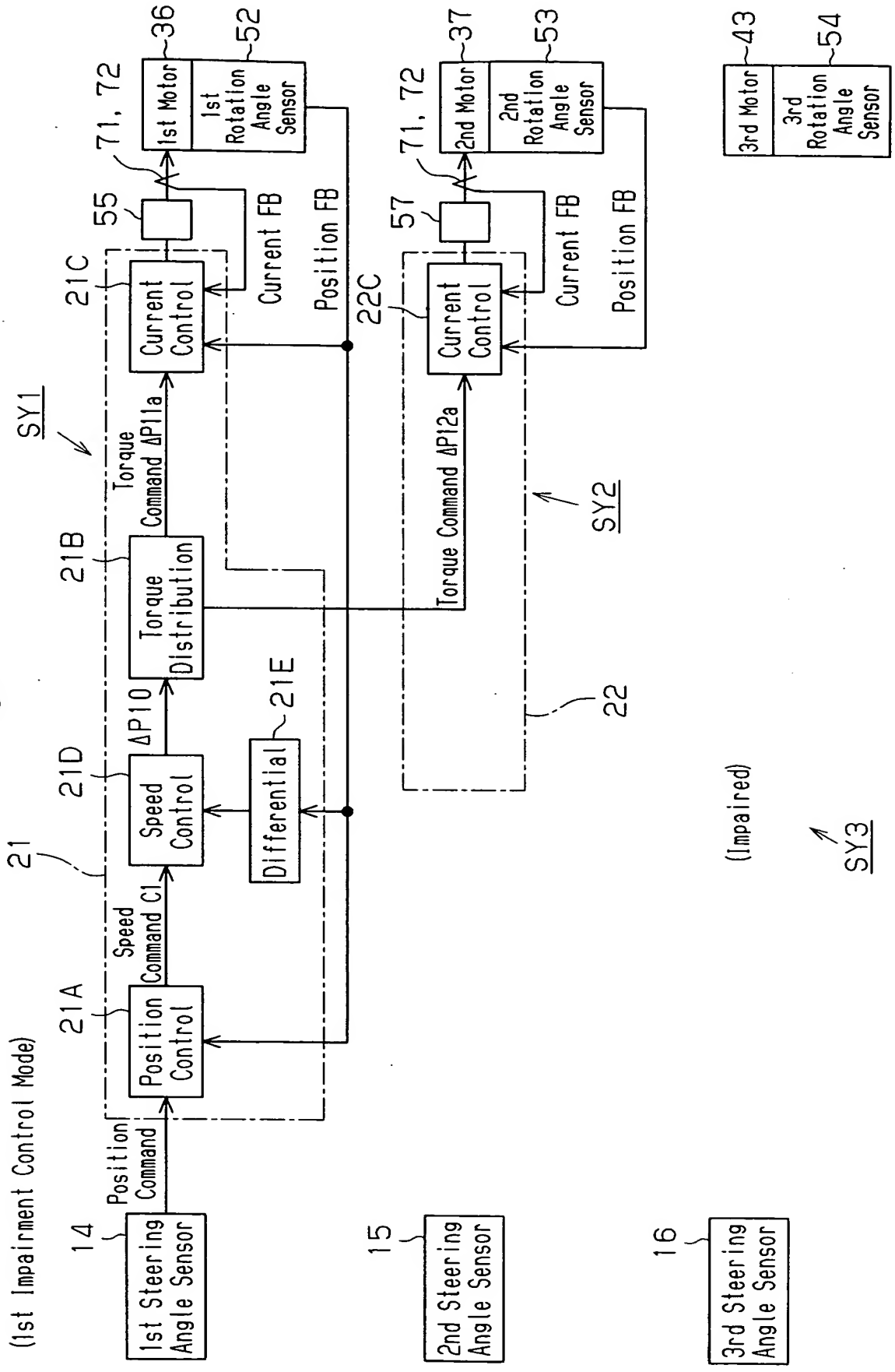

(1st Impairment Control Mode)
SY1
SY2
SY3
(Impaired)
21
21A
21B
21C
21D
21E
22
22C
Position Control
Speed Control
Torque Distribution
Current Control
Differential
Current Control
Speed Command C1
ΔP10
Torque Command ΔP11a
Torque Command ΔP12a
Position Command
Current FB
Position FB
Current FB
Position FB
55
57
71, 72
71, 72
1st Motor
2nd Motor
3rd Motor
36
37
43
1st Rotation Angle Sensor
2nd Rotation Angle Sensor
3rd Rotation Angle Sensor
52
53
54
14
15
16
1st Steering Angle Sensor
2nd Steering Angle Sensor
3rd Steering Angle Sensor

Fig.16

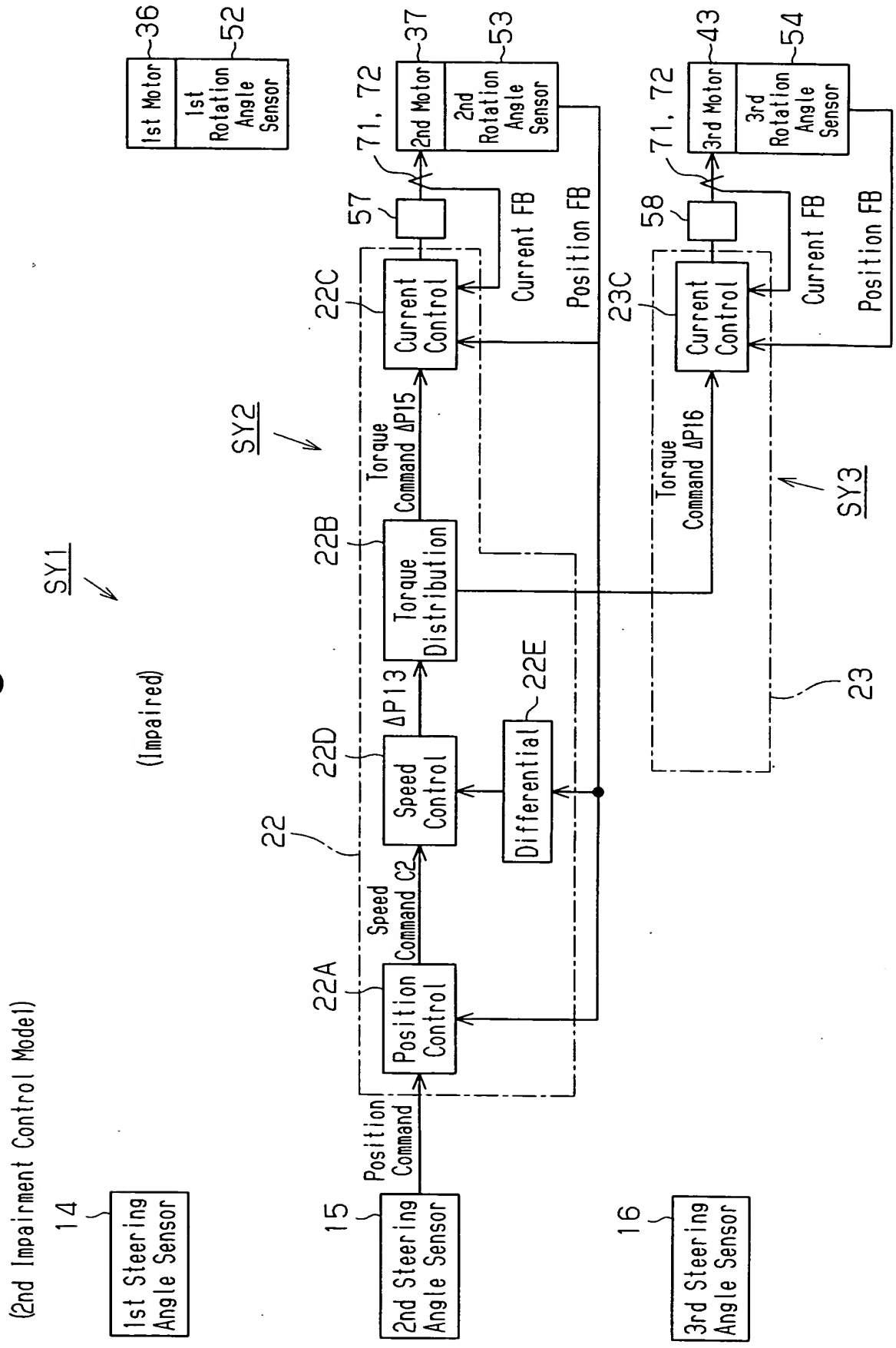
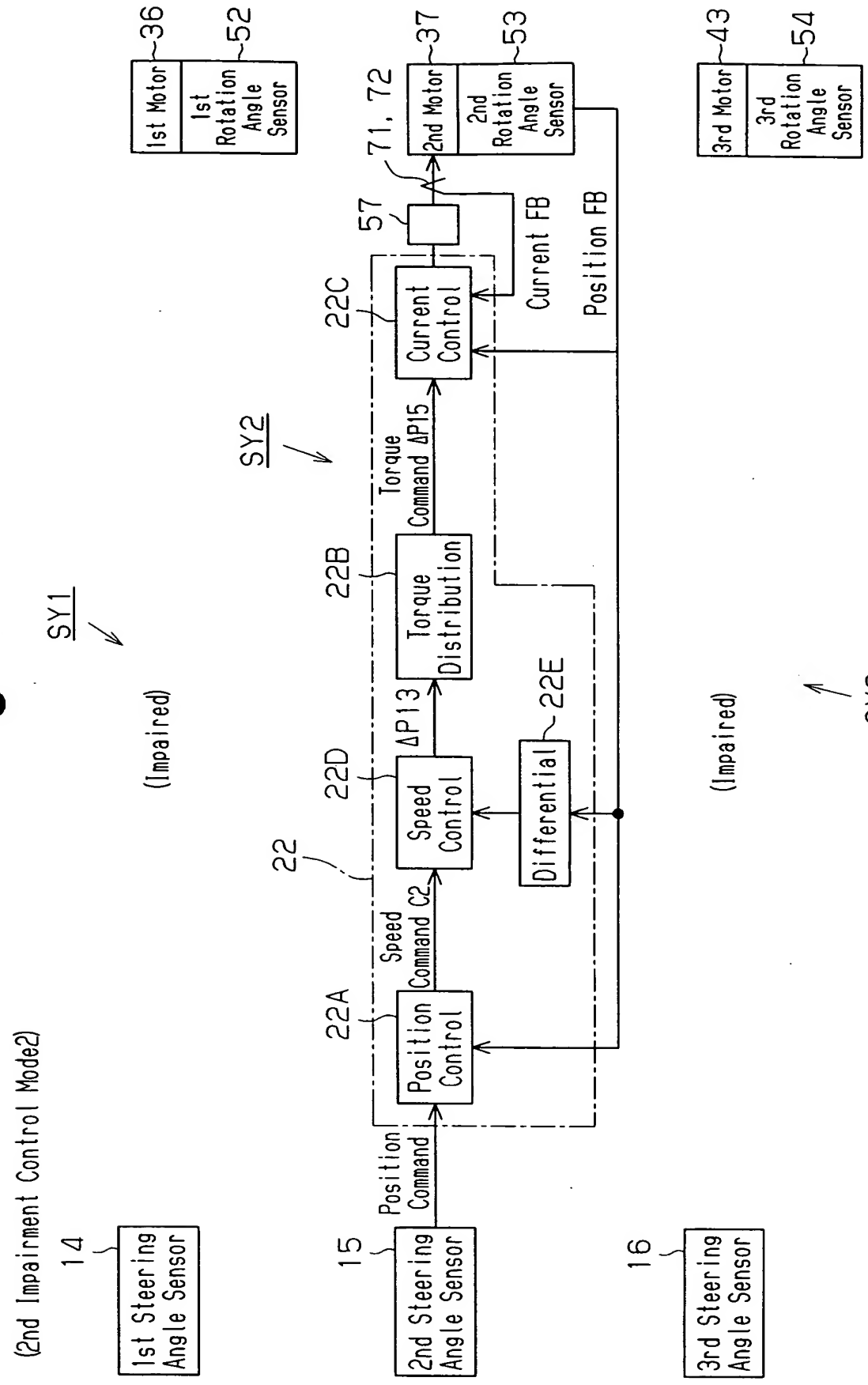

(2nd Impairment Control Model)
(Impaired)
SY1
SY2
SY3
14
1st Steering Angle Sensor
15
2nd Steering Angle Sensor
16
3rd Steering Angle Sensor
22
22A
Position Control
Position Command
22B
Torque Distribution
22C
Current Control
22D
Speed Control
22E
Differential
23
23C
Current Control
Speed Command C2
ΔP13
Torque Command ΔP15
Torque Command ΔP16
Current FB
Position FB
Current FB
Position FB
57
58
71, 72
71, 72
1st Motor
36
1st Rotation Angle Sensor
52
2nd Motor
37
2nd Rotation Angle Sensor
53
3rd Motor
43
3rd Rotation Angle Sensor
54

Fig.17


(2nd Impairment Control Mode2)
14
1st Steering Angle Sensor
15
2nd Steering Angle Sensor
16
3rd Steering Angle Sensor
Position Command
22A
Position Control
Speed Command C2
22D
Speed Control
22
ΔP13
22B
Torque Distribution
Torque Command ΔP15
22C
Current Control
57
71, 72
SY1
(Impaired)
SY2
22E
Differential
Current FB
Position FB
SY3
(Impaired)
1st Motor
36
1st Rotation Angle Sensor
52
2nd Motor
37
2nd Rotation Angle Sensor
53
3rd Motor
43
3rd Rotation Angle Sensor
54

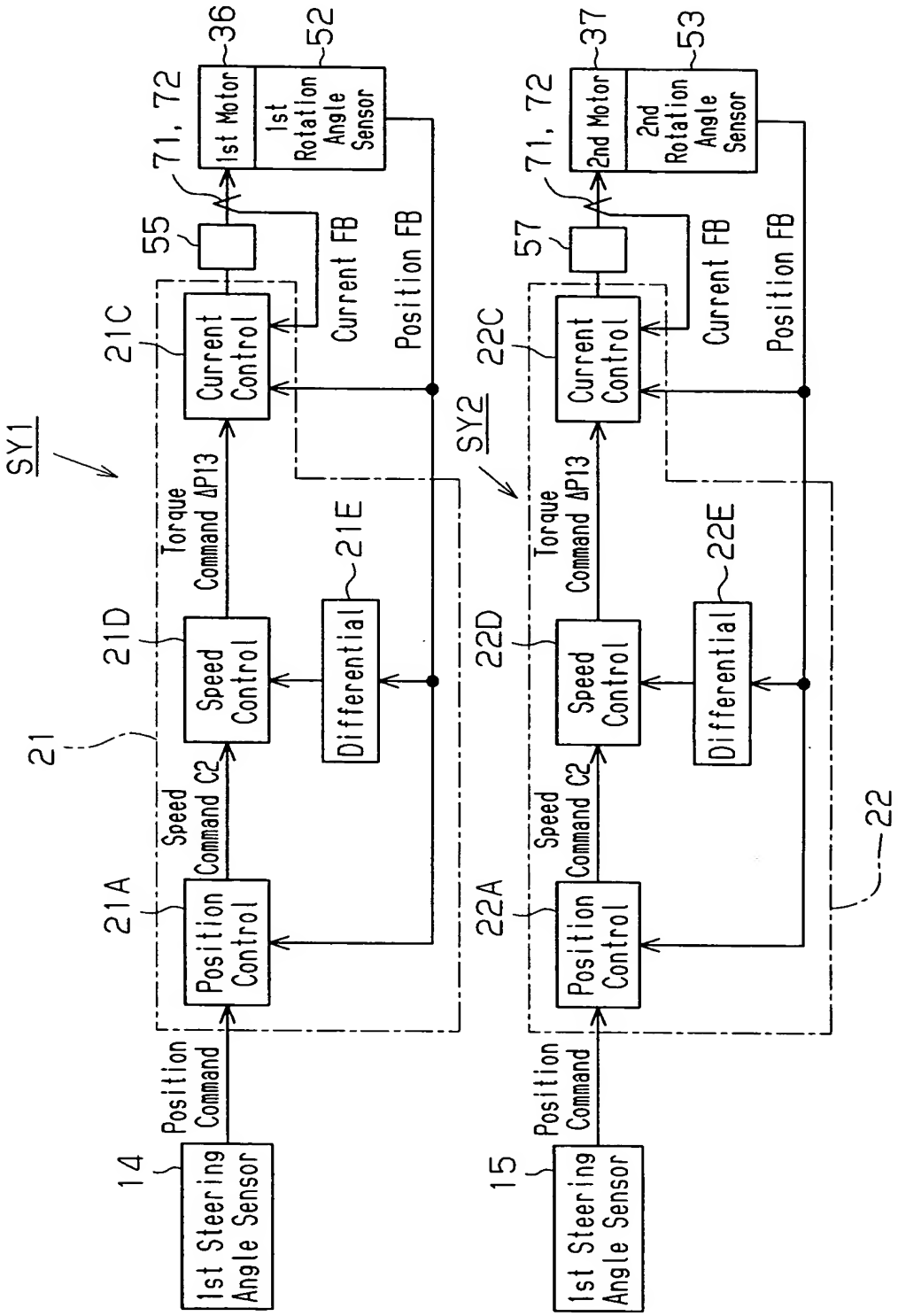



Fig.18(Prior Art)